

Simulation of group-velocity-dependent phase shift induced by refractive-index change in an air-bridge-type two-dimensional photonic crystal slab waveguide

Y. Watanabe¹, Y. Sugimoto^{1,2}, H. Nakamura², and K. Asakawa^{1,2}

¹ Center for TARA, University of Tsukuba, Tsukuba 305-8577, Japan

² FESTA, Tsukuba 300-2635, Japan

We present here a numerical analysis of the group velocity (v_g) dependent phase shift induced by the small changes of the refractive index (Δn) in the 2D photonic crystal (PC) slab waveguide. The calculation was based on a 3D FDTD method for the design of a phase shift arm of the PC-based symmetric Mach-Zehnder (PC-SMZ) type all-optical switch. As shown in Fig. 1, Δn was assumed to be induced by an optical nonlinearity of quantum dots embedded in the phase shift arm. It was shown that the arm length necessary for the switch is significantly reduced because of the low v_g in spite of the small Δn . For example, the arm length was evaluated to be $\sim 100\mu\text{m}$ for Δn of ~ 0.001 , v_g of $0.03c$, and a lattice constant of $0.36\mu\text{m}$ at a wavelength of $\sim 1.3\mu\text{m}$ (c is the light velocity). The resultant waveguide length is short enough to achieve a compact ultrafast all-optical switch.

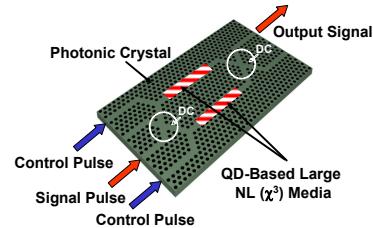


Fig. 1: Schematic of a PC-SMZ switch.

- [1] Y. Watanabe et al., *J. Opt. Soc. Am. B* **21**, 1833 (2004).